

# Department of Education

# Science 9

## CARBON ATOM: Its Structure and Characteristics Second Quarter - Week 4



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## EXPECTATIONS

Hello Learner! You are now in the 4<sup>th</sup> week and approaching the end of your chemistry lesson this quarter. In this module, you should be able to demonstrate an understanding of the type of bonds that carbon forms that result in the diversity of carbon compounds.

At the end of the module, you should be able to:

**Explain how the structure of the carbon atom affects the type of bonds it forms (S9MT-IIg-h-17)**

Specifically, you will be able to:

1. discuss why carbon is a unique atom (valence electron, bond length, strength, multiple bond formation, etc.) and
2. differentiate organic from inorganic compounds (from its chemical formula, uses, properties).

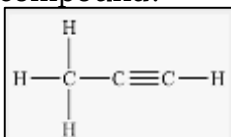


## PRE-TEST

**Directions:** Write the letter of the correct answer on the space provided before each number.

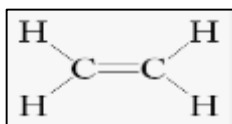
- \_\_\_ 1. How many valence electrons does a carbon atom have?  
A. 3                      B. 4                      C. 5                      D. 6
- \_\_\_ 2. How many bonds can a carbon atom form?  
A. 3                      B. 4                      C. 5                      D. 6
- \_\_\_ 3. Which of the following pairs of organic compounds is highly flammable?  
A. gasoline, acetone                      C. lubricating oil, isopropyl alcohol  
B. Liquefied Petroleum Gas, kerosene   D. water, ethyl alcohol
- \_\_\_ 4. Which of the following statements best describes organic compounds?  
A. Organic compounds contain carbon atoms only.  
B. Organic compounds contain carbon and oxygen only.  
C. Organic compounds are produced only by living things.  
D. Organic compounds are composed of carbon and hydrogen only.
- \_\_\_ 5. How do carbon atoms form many organic compounds?  
A. By attracting other elements towards themselves to form the bonds  
B. By bonding with other carbon atoms and other elements  
C. By sharing electrons with metal and non-metal elements  
D. By transferring their electrons to the atoms of surrounding elements
- \_\_\_ 6. Which of the following chemical formulas describes an organic compound?  
A. CH<sub>4</sub>                      B. CO                      C. CO<sub>2</sub>                      D. NH<sub>3</sub>
- \_\_\_ 7. A gasoline boy was scolded by his store manager for smoking in the vicinity of the gasoline station. The manager scolded his employee because gasoline is \_\_\_?

- A. dangerous  
 B. flammable  
 C. viscous  
 D. volatile
- \_\_\_8. Jaime scratched herself when her arm bumped into the concrete post. What substance should she apply to make her bruises free from harmful germs?
- A. acetone  
 B. formalin  
 C. isopropyl alcohol  
 D. water
- \_\_\_9. Which hydrocarbon compound has a triple bond in the molecule?
- A. ethene  
 B. ethyne  
 C. methane  
 D. octane
- \_\_\_10. How many types of covalent bonds are there in the following hydrocarbon compound?



<https://tinyurl.com/ucla-kekule-structure> on 09.25.20

- A. 1  
 B. 2  
 C. 3  
 D. 4
- \_\_\_11. To which group of hydrocarbon does the molecule with the structure below belong?



<https://tinyurl.com/simon-cotton-ethene> on 09.25.20

- A. Alkane  
 B. Alkadiene  
 C. Alkene  
 D. Alkyne
- \_\_\_12. What is the common use of methane?
- A. disinfectant  
 B. fertilizer  
 C. fuel  
 D. ripening agent
- \_\_\_13. Which alkane will most likely have a very low boiling point?
- A. propane  
 B. pentane  
 C. butane  
 D. hexane
- \_\_\_14. Which of the following is an organic compound?
- A. carbon Dioxide  
 B. ethyl Alcohol  
 C. water  
 D. sodium chloride
- \_\_\_15. Which of the following properties differentiates an organic compound from an inorganic compound?
- A. have high boiling points  
 B. have high melting points  
 C. most are soluble in polar solvents  
 D. can be large molecules with many atoms



## LOOKING BACK

**Directions:** Draw the Lewis Dot Structure of the following compounds.

COMPOUND	Lewis Dot Symbol
H <sub>2</sub> O (Dihydrogen Monoxide or Water)	
CO <sub>2</sub> (Carbon Dioxide)	
NH <sub>3</sub> (Nitrogen Trihydride or Ammonia)	

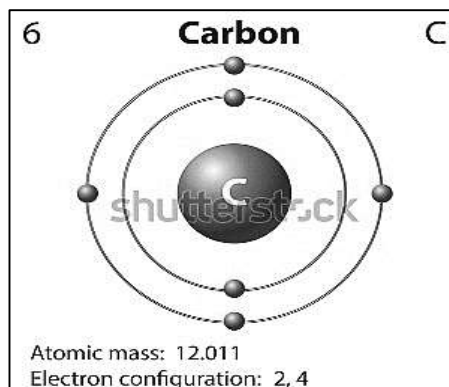


## BRIEF INTRODUCTION

Let's begin by knowing the basic characteristic of the carbon atom. **Carbon** is a non-metal element which belongs to Group 4A and the 6<sup>th</sup> element in the Periodic Table of Elements with atomic number six. Recall that the atomic number is the same with the number of protons and for neutral atoms, the number of electrons. This means that a neutral atom has equal number of protons and electrons. Carbon has six electrons with two of its electrons already filled the first main energy level, while its four electrons are located on the second main energy level which is the outermost shell (see Image 1). This shows that carbon has four valence electrons. Remember that valence electrons refer to electrons found in the outer most shell of atom which are available for forming bonds with other elements. Since it is a non-metal with four valence electrons, it shares electrons to form covalent bond and reach stability. Carbon is a unique element because each carbon atom in a compound can form four chemical bonds with other carbon atoms and atoms of other elements resulting in the formation of many different compounds. It can be in **single, double and triple bonds**. They differ in the number of electron pairs shared: single – one pair, double – two pairs, and triple – three pairs. There are differences in the bond length and strength for single, double and triple bonds. **The more bonds are formed, the closer and stronger the bond will be between atoms**, (Refer to Table 1).

Compounds that contain carbon-hydrogen bonds are called **organic compounds** which are often described as naturally-occurring and mostly found in living organisms, hence, the term organic. The main examples of organic compound are nucleic acid found in DNA and RNA, proteins, lipids, carbohydrates, and hydrocarbons like methane (CH<sub>4</sub>).

In Module 3, you learned how ionic compounds are formed by the transfer of electrons from metal to nonmetal. The chemical formulas of organic compounds are simple and some contain carbon but not the carbon-hydrogen bond that is found in organic compounds. Examples of inorganic compounds are NaCl, CO<sub>2</sub>, and KNO<sub>3</sub>.



**Image 1:** Carbon Atom Illustration

<https://tinyurl.com/shutterstock-carbon-atom-model> on 09.25.20

**Table 1:** Bond Length and Strength Relationship

	Bond Lengths and Bond Energies	
	Bond Length (nm)	Bond Energy (kJ/mol)
H-H	0.074	435
H-Cl	0.127	431
Cl-Cl	0.198	243
H-C	0.109	414
C-Cl	0.177	328
C-C	0.154	331
C=C	0.134	590
C≡C	0.120	812
C-O	0.143	326
C=O	0.120	803
C≡O	0.113	1075
N-N	0.145	159
N=N	0.125	473
N≡N	0.110	941

<https://tinyurl.com/chem-bond-length-strength> on 09.25.20

The table below gives the differences between organic and inorganic compounds based on their characteristics.

ORGANIC COMPOUNDS	INORGANIC COMPOUNDS
Carbon compounds	Have metals in salts & oxides
Have covalent bonds	Have ionic or polar covalent bonds
Have low melting points	Have high melting points
Have low boiling points	Have high boiling points
Most burn in air	Few burn in air
Most are soluble in nonpolar solvents	Most are soluble in polar solvents
Most are nonelectrolytes	Many are electrolytes
Can be large molecules with many atoms	Usually small with few atoms
Ex. $\text{CH}_4$ , $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{COOH}$	Ex. $\text{NaCl}$ , $\text{MgBr}_2$

**Hydrocarbons** are organic compounds that contain carbon and hydrogen atoms only. Alkanes, alkenes, and alkynes are the three main classes of hydrocarbons. They differ in the type of bonds present: alkane, single bond (-), alkene, double bond (=), and alkyne, triple bond, ( $\equiv$ ).

SOME EXAMPLES OF HYDROCARBONS					
Alkanes ( $\text{C}_n\text{H}_{2n+2}$ )		Alkenes ( $\text{C}_n\text{H}_{2n}$ )		Alkynes ( $\text{C}_n\text{H}_{2n-2}$ )	
Name	Formula	Name	Formula	Name	Formula
methane	$\text{CH}_4$	-	-	-	-
ethane	$\text{CH}_6$	ethene	$\text{C}_2\text{H}_4$	ethyne	$\text{C}_2\text{H}_2$
propane	$\text{CH}_8$	propene	$\text{C}_3\text{H}_6$	propyne	$\text{C}_3\text{H}_4$
butane	$\text{CH}_{10}$	butene	$\text{C}_4\text{H}_8$	butyne	$\text{C}_4\text{H}_6$

Notice that the suffix of the name indicates the type of hydrocarbon, e.g. meth**ane** is an alk**ane**.









## ACTIVITIES

### ACTIVITY 1: Uses of Organic Compounds

Organic compounds are very useful and can be found easily at home. Some organic compounds can be used as fuel in automobile vehicles and in cooking our food, as antiseptic for disinfection in hospitals and even at home like isopropyl alcohol. Refer

to Table 2: Uses of Organic Compounds and complete it by using a check mark (✓) indicating its use. You may have more than one check (✓) mark per sample depending on its use/s. You can do it!

Table 2: Uses of Organic Compounds		Gasoline	Ethanol	Acetone	LPG	Kerosene	Acetic Acid
							
USES	Beverage						
	Food						
	Antiseptic						
	Fuel						
	Cleaner						

Derived from: Science 9: Learning Module. Department of Education, page 132.

### ACTIVITY 2: Properties of common Organic Compounds

Objectives:

1. Observe the properties of common organic compounds.
2. Relate these properties to their uses.

Materials:

- Kerosene (optional)
- Baby oil
- Ethyl alcohol (or any disinfecting alcohol)
- Cooking oil
- 4 Medicine Droppers (or disposable spoon)
- Stopwatch
- Paper and pen
- Calculator
- A box of matches
- 4 disposable plastic/transparent cup
- Card board as incline (to form slant slope)
- 4 bottle crown (*Tansan*)
- 4 ¼ cut of long bond paper
- cotton buds



Follow the procedures carefully because you are about to use flammable substances. Prepare sand or wet rags to be used in case of fire. To smell the odor of a chemical, waft or fan the fumes toward your nose with one hand.

### PROCEDURE:

Table 3: Properties of Common Organic Compounds

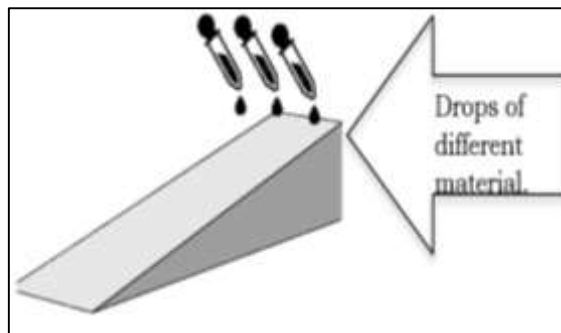
Materials	Odor	Phase	Viscosity (Average time a drop takes to reach the bottom)	Volatility (Average time it takes a liquid to evaporate)	Flammability (Average time it takes for a material to burn completely)
Kerosene					
Baby oil					
Cooking oil					
Ethyl alcohol (or any disinfecting alcohol)					

## I. Preparations

- Use the table to record your observations from this activity.
- Place 15 ml (or 3 spoon-full) of each liquid in the four identical cups and label each cup according to the liquid it contains.
- Observe the materials and write the phase (solid, liquid or gas) and odor of the material on the table.

## II. Testing the Viscosity of the materials.

- Using the card board, form an incline or slant slope like the one side of a mountain.
- Drop a small amount of the material on the top of the slope, then use your stopwatch to determine the time it takes to reach the bottom of the inclined card board.



*Credit: Daisy Rodelas: Activity 2 Illustration*

- Procedure A and B should look like the illustration above.

## III. Testing the Volatility of the Materials

- Using a medicine dropper (disposable spoon), put two drops of each liquid material on the separate pieces of bond paper. You should do this at the same time and place it on a clean table.
- Record the time it takes until papers get dry. This is equivalent to the time it takes the liquid to completely evaporate.

## IV. Testing for Flammability of the Materials



Wear a face mask before performing the following procedure.  
Have the sand or wet rags near you while doing the test for flammability.

- Prepare four bottle crown (*tansan*) and then place a cotton bud in each bottle crown.
- Wet the cotton buds with 10 drops of the liquid materials.
- Ignite each wet cotton bud using a lighted match stick(*posporo*).
- Record the time it takes until each cotton bud burned completely.
- Repeat steps A, B, C, and D 4x more so that you will have five trials per liquid material.
- Compute for the average time it takes each set up to burn completely.

*\*\*This activity is adapted, with some minor revision, from the Grade 9-Science Learners Module of Department of Education page 133-135.*

### Guide Questions:

- Which material is most viscous? \_\_\_\_\_.
- What are the common uses of viscous materials?  
\_\_\_\_\_.
- Which materials are flammable? \_\_\_\_\_.
- What are the common uses of flammable materials?  
\_\_\_\_\_.
- Which liquid materials have strong odor? weak odor?  
\_\_\_\_\_.

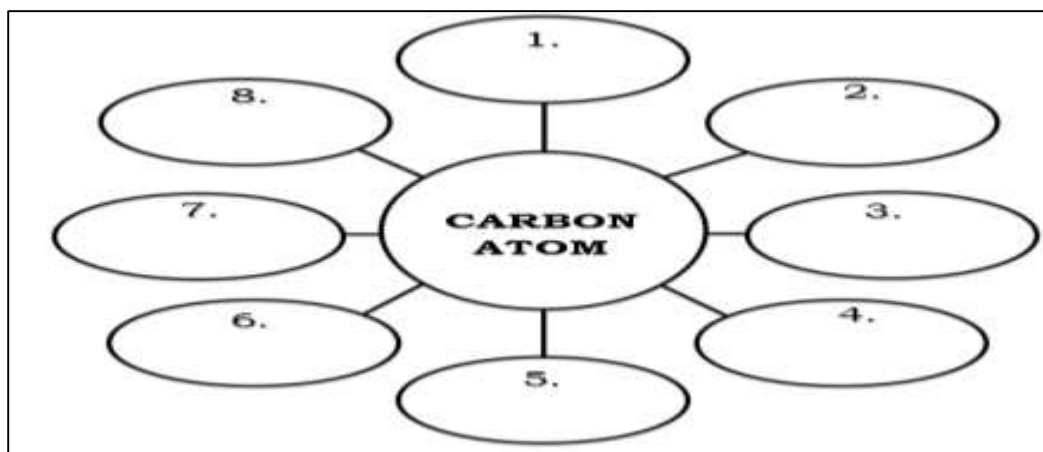
6. Why is it important to know the properties of organic compounds?

In this activity, you have learned about the properties of some known organic compounds and their relationship to their uses.



#### REMEMBER

**Directions:** Complete the Concept Map with all the ideas you have learned about the carbon atom.



<https://tinyurl.com/goalbook-concept-map> on 09.25.20



#### CHECK YOUR UNDERSTANDING

**Directions:** Identify the compound whether it is an organic or inorganic compound by ticking (✓) the box.

	Organic Compound	Inorganic Compound
NaOH (sodium hydroxide)		
CH <sub>3</sub> OH (methyl alcohol)		
C <sub>6</sub> H <sub>6</sub> (benzene)		
Mg(NO <sub>3</sub> ) <sub>2</sub> (magnesium nitrate)		
NaCl (sodium chloride)		



#### POST TEST

**Directions:** Write the letter of the correct answer on the space provided before each number.

\_\_1. Which of the following compounds has a triple bond?

- A. Alkane                      B. Alkadiene                      C. Alkene                      D. Alkyne

**For numbers 2 & 3:**

- A. H - H                      B. C - C                      C. C = C                      D. C ≡ C

\_\_2. Which of the following has the shortest bond length?

\_\_3. Which of the following has the strongest bond strength?



- \_\_4. Which of the following formulas indicates an alkyne?  
 A.  $C_3H_4$       B.  $C_3H_6$       C.  $C_3H_8$       D.  $C_3H_{10}$
- \_\_5. What is the main difference of organic from inorganic compounds?  
 A. Organic compounds contain carbon atom but inorganic compounds do not.  
 B. Organic compounds contain carbon-hydrogen bond which is not present in inorganic compound.  
 C. Organic compound can only be found in living matters while inorganic compound in non-living matter.  
 D. Organic compound and inorganic compound are the same.
- \_\_6. Which of the following is **not** a characteristic of organic compounds?  
 A. can form ionic bonds  
 B. contain covalent bonds  
 C. contain carbon-hydrogen bond  
 D. can be used as fuel and/or disinfectant
- \_\_7. What is true about the difference in bond length in single, double, and triple bonds between atoms?  
 A. The more bonds between atoms, the shorter the bond is.  
 B. The more bonds between atoms, the longer the bond is.  
 C. The lesser bonds between atoms, the more normal the bond is.  
 D. The number of bond does not affect the bond length between atoms.
- \_\_8. Which of the following characteristics describes an organic compound?  
 A. have high boiling points      C. most are soluble in polar solvents  
 B. have high melting points      D. can be large molecules with many atoms
- \_\_9. Which of the following is an example of an organic compound used as fuel?  
 A. acetic acid      C. nucleic acid  
 B. gasoline      D. proteins
- \_\_10. All of the following are uses of ethyl alcohol, EXCEPT as \_\_\_\_.  
 A. fuel      C. component in beverage  
 B. disinfectant      D. perfume
- \_\_11. Lucy sprayed her hands with isopropyl alcohol before entering the mall for safety. What use of organic compounds is exhibited?  
 A. as fragrance      C. as cleaning solution  
 B. as disinfectant      D. as replacement for water
- \_\_12. Andrew bought kerosene from the store to light up his lamp. What use of organic compounds is exhibited?  
 A. as fuel      C. as source of fire  
 B. as disinfectant      D. as source of light
- \_\_13. Cassie wears her favorite perfume whose floral scent was smelled immediately by the people in the room. What property of organic compounds is exhibited?  
 A. combustibility      C. viscosity  
 B. flammability      D. volatility
- \_\_14. The NO SMOKING sign is always posted in gasoline stations. Which of the following statements best explains this?  
 A. Better be safe than sorry.  
 B. Posting the sign is a rule.  
 C. Gasoline is flammable and might result to fires.  
 D. Gasoline is an organic compound that might start fire.

**For numbers 15-20:** Identify whether the compound is an **organic** or **inorganic**

- |                        |                          |
|------------------------|--------------------------|
| _____ 15. Nucleic acid | _____ 18. Fats           |
| _____ 16. Table salt   | _____ 19. Ethanol        |
| _____ 17. Sugar        | _____ 20. Carbon dioxide |

## ANSWER KEY:

1. B	2. A	3. B	4. D	5. B
6. A	7. D	8. C	9. B	10. B
11. C	12. C	13. C	14. C	15. D

### PRE-TEST

	HCl (Hydrochloric Acid)
	NH3 (Nitrogen or Ammonia)
	CO2 (Carbon Dioxide)
	H2O (Dihydrogen Monoxide or Water)

### LOOKING BACK

Uses	Beverage	Food	Antiseptic	Fuel	Cleaner
Gasoline	Acetic Acid	Kerosene	Acetic Acid	Acetic Acid	Acetic Acid

### ACTIVITY 1:

1. D	6. A	11. B	16. Inorganic
2. D	7. A	12. A	17. Organic
3. D	8. D	13. D	18. Organic
4. A	9. B	14. C	19. Inorganic
5. B	10. B	15. Organic	20. Inorganic

### POST TEST

Organic Compound	Organic Compound	NaOH (Sodium Hydroxide)
		CH <sub>3</sub> OH (Methyl Alcohol)
		C <sub>6</sub> H <sub>6</sub> (Benzene)
		Mg(NO <sub>3</sub> ) <sub>2</sub> (Magnesium Nitrate)
		NaCl (Sodium Chloride)

### CHECK YOUR UNDERSTANDING

1. Lubricating Oil (result may vary w/ different material)
2. Use for lubricating machines and to avoid rusting.
3. Kerosene, Lubricating Oil, Diesel Oil, Ethyl Alcohol
4. Used as fuel.
5. Kerosene, Lubricating Oil.
6. Answers will vary.

1. The 6 <sup>th</sup> element.
2. Belongs in Group 4A
3. Has 4 Valence electrons
4. Can be found in Organic Compounds
5. Also found in Inorganic Compounds
6. Forms covalent bonds with other atom
7. Can form different types of bonds with other elements and with carbon as well.
8. small size atom which fits to other larger molecules.

### REMEMBER: Carbon Atom

## References:

Science 9: Learning Module. Department of Education.

### E-Source

Anne Marie Helmenstine, The Difference between Organic and Inorganic: 2020: <https://tinyurl.com/diff-org-inorg> on 09.21.20

<https://tinyurl.com/ion-concepts> on 09.16.2020

<https://tinyurl.com/emp-mole-struc-formula/> on 09.14.2020

<https://tinyurl.com/special-carbon> on 09.14.2020

<https://tinyurl.com/imp-org-comp-uses> on 09.21.20

<http://misterguch.brinkster.net/PRA017.pdf> on 10.20.20

### Images:

Daisy Rodelas: Activity 2 Illustration

<https://tinyurl.com/ucla-kekule-structure> on 09.25.20

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<https://tinyurl.com/shutterstock-carbon-atom-model> on 09.25.20

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